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**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re application of:

Wayne D. Young

Application No.: 10/796,695

Filed: March 8, 2004

For: ERROR ACCUMULATION  
DITHERING OF IMAGE DATA

Confirmation No. 2868

Examiner: Aaron M. Richer

Technology Center/Art Unit: 2628

APPELLANTS' BRIEF UNDER  
37 CFR §41.37

Mail Stop Appeal Brief  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

Sir:

Further to the Notice of Appeal mailed on August 8, 2007, for the above-referenced application, Appellants submit this Brief on Appeal.

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## **1. REAL PARTY IN INTEREST**

At the time of the filing of this Appeal Brief, NVIDIA Corporation is the real party in interest for this appeal.

## **2. RELATED APPEALS AND INTERFERENCES**

No other appeals or interferences are known which will directly affect, are directly affected by, or have a bearing on the board decision of the pending appeal.

## **3. STATUS OF CLAIMS**

Claims 1-3 and 6-20 are currently pending in the application, but stand rejected by the Examiner. Claims 1-3 and 6-20 are believed improperly rejected and are the subject of this appeal. A copy of the claims as rejected is attached as an Appendix.

## **4. STATUS OF AMENDMENTS**

An amendment dated February 28, 2007, was filed and entered in response to the Office Action mailed September 29, 2006. A Final Office Action ("Final Office Action") was mailed May 8, 2007. No amendments are unentered.

## **5. SUMMARY OF CLAIMED SUBJECT MATTER**

Claims 1, 12, and 20 are the independent claims. In the following summary, Appellant provides references to sections of the Specification and Drawings supporting the subject matter defined in the claims as required by 37 C.F.R. §41.37. These references are intended to be illustrative in nature only. The claimed subject matter relates to methods and devices for dithering an image.

Independent claim 1 sets forth a method of dithering an image. A target color at a high color resolution is received for a current one of a number of pixels of the image, the target color being intermediate between a first color and a second color at a low color resolution (Original Application, p. 3, ll. 14-16; p. 8, ll. 26-28). An accumulated error is tracked across the pixels, up to and including the current pixel (Id., p. 3, ll. 16-17; p. 8, l. 30; p. 9, ll. 11-12).

One of a first color and a second color are selected as a final pixel color, wherein the first color is selected in the event that the accumulated error is less than a threshold, wherein the second color is selected in the event that the accumulated error exceeds the threshold, and wherein the accumulated error is reduced below the threshold in the event that the second color is selected (Id., p. 3, ll. 17-19; p. 9, ll. 17-20). An updated accumulated error is provided to the next one of the number of pixels (Id., p. 3, l. 21; p. 8, l. 30). The selected final pixel color for display on a display device (Id., p. 7, ll. 9-11).

Independent claim 12 sets forth a device for dithering an image. The device includes an accumulator module configured to track an accumulated error across a plurality of pixels of the image (Id., p. 4., ll. 5-7; p. 10, ll. 12-23; ref. num. 320). A conversion module is configured to receive a high resolution color signal for a current pixel of the image and to generate a corresponding low resolution color signal (Id., p. 4., ll. 7-8; p. 11, ll. 6-8; ref. num. 336). An adjustment module is configured to modify the low resolution color signal from a first color to a second color for the current pixel in the event that the accumulated error exceeds a threshold (Id., p. 4., ll. 9-10; p. 10, l. 29 - p. 11, l. 4; ref. num. 330). An output module is configured to output the low resolution color signal for the current pixel for display on a display device (Id., p. 7, ll. 9-11; ref. num. 224). After processing the current pixel, the accumulated error is provided to a next one of the plurality of pixels (Id., p. 3, l. 21; p. 8, l. 30).

Independent claim 20 sets forth a graphics processing unit for dithering an image. Claim 20 recites a scanout module which includes certain elements from claim 12, and additionally includes a geometry pipeline unit configured to generate pixel data for an image (Id., p. 6, ll. 19-23).

## **6. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL**

**Ground of Rejection I:** Independent claims 1, 12, and 20, and dependent claims 2, 3, 10, 11, 13-15, 17, and 18, stand rejected under 35 U.S.C. §102(b) as being anticipated by the cited portions of Quintana, U.S. Publication No. 2004/0100646 ("Quintana").

## **7. ARGUMENT**

### **Ground of Rejection I:**

The Final Office Action rejected independent claims 1, 12, and 20, and dependent claims 3 and 14, under 35 U.S.C. §102(e) as being anticipated by Quintana. For a valid anticipation rejection, the Office must show that each limitation from the claims appears in a single piece of prior art. Appellant, however, believes that significant limitations from these claims are not taught or suggested by Quintana.

Specifically, Quintana cannot be relied upon to teach or suggest 1) selecting one of a first color or second color as a **final pixel color**, or 2) the recited process of **selecting** between one of a **first color** or **second color**, as generally set forth in independent claims 1, 12, or 20. While noting that these distinctions are intertwined, they will nonetheless be addressed separately. Moreover, the limitations from dependent claim 3 are not taught or suggested by Quintana, and this claims will be argued separately.

#### **Independent Claims 1, 12, and 20:**

**Final Pixel Color:** The independent claims generally provide for selecting between a "first color" and "second color" for a ***final pixel color***. But in Quintana, there is no selection between a first color and a second color for a final pixel color. Instead, the method disclosed in Quintana involves the determination whether to output an output pixel, or not (Quintana, ¶14, 15, 18, 26, and 32). If the output pixel for the color is not output, determinations as to whether to output other colors as the final pixel color for the pixel are then made.

The Final Office Action appears to assert that this is merely a matter of semantics, stating that in Quintana, "a pixel that is ... not output still has a 'final pixel color', that pixel color being equivalent to white" (Final Office Action, p. 2, ll. 9-10). This assertion is factually incorrect, as the decision to not output a pixel in Quintana does not as a matter of course produce the color white. Instead, in Quintana:

if the method 100 has determined to ***not output*** an output pixel for the color component in 102 (104), and there are further color components of the image pixel (110), ***then the method 100 proceeds to advance to the next color component (112), and repeats 102, 104,***

and so on. For example, where the method 100 starts with the darkest color component, it then advances to the next-darkest color component, and so on, until the lightest color component is reached. (Quintana, ¶18)

In Quintana, therefore, a determination to not output an output pixel causes the output determination process to continue for a next darkest color component. A decision to not output a pixel in Quintana does not as a matter of course cause "white" to be output. The decision to not output a pixel in Quintana causes no output pixel to be output for that color, and triggers other color determinations for the pixel to be undertaken. Thus, while the claims recite a selection process to choose between a first and second color as the final pixel color, Quintana differs. The determination in Quintana is whether to output an output pixel, or not. If not, the selection of a final pixel color may be a multi-step color determination process that further differs from the claims.

Even assuming, *arguendo*, that the decision not to output of Quintana was equivalent to white, this would not be the final pixel color. Instead, this merely triggers other color determinations for the pixel to be undertaken to choose the final pixel color.

In the Advisory Action dated July 16, 2007, the Office continues to misinterpret this functionality of Quintana. The Office asserts that the "Quintana reference deals with printers and therefore does not print a pixel when it has been decided that white is the correct color for a pixel location, and that the effect is equivalent to 'choosing' white as a color, much like a monitor would have an 'off' pixel in black areas" (Advisory Action, p. 2).

To address these contentions, Appellants ask the Board to again refer to the remarks above. As noted, a decision to not output a pixel in Quintana does not cause "white" to be the final pixel color, but instead causes no output pixel to be output for that color, and triggers other color determinations for the current pixel to be undertaken. The Office asserts that "Quintana ... does not print a pixel" when a determination to not output a pixel is made. But this again mischaracterizes Quintana, as in fact a different color for the current may be printed based on other color determinations. The claims teach a different process, as the final pixel color is identified from the recited process of selection between a first color or second color.

**Selecting Between First Color and Second Color for Output:** As introduced above, the independent claims generally provide for selecting between a "first color" and "second color." In Quintana, the determination at issue involves whether to output a *current color component* for the current pixel, *or not*.

Thus, in Quintana, if "the method 100 has determined to output the output pixel (104), then the output pixel for the color component of the image pixel is output (106)" (Quintana, ¶16). If not, there is no output, and thus the selection at issue is not between two colors, as claimed (See Quintana, ¶15, "an output pixel [that] has not been output means the output has an off state"; in ¶18 the method "determined to not output an output pixel"; in ¶26, the method determines "whether an output pixel should be output"; in ¶32, "no output pixel has been output"). A choice between a "first color" and "second color" differs from a decision whether to output a particular color, or not. A decision *not to output* a color component for a pixel differs from a decision to select a second color for an image pixel.

Moreover, once an output pixel is output, other color components of the current pixel are spaced out to other pixels (Quintana, ¶17). This further illustrates differences between the teachings of the reference and the claims. Aspects of Quintana are specifically directed to spacing out output of output pixels (See Quintana, ¶17 and claim 1). In Quintana, the decision to output triggers spacing of other color components of the current pixel, while the decision not to output triggers additional color determinations for the current pixel. This closer examination of Quintana illustrates how the printer-focused technique of Quintana fails to suggest the limitations set forth in the claims.

The Office concedes that in Quintana, a "pixel ... is turned off, or not output," which plainly differs from the present claims (Final Office Action, p. 2, l. 9). The Office nonetheless appears to contend that a decision to **not output an output pixel** in Quintana is *equivalent* to the decision to **output the second color** for the current pixel, as set forth in the claims.

In the Final Office Action, no cite is made to a reference in the art *itself* for this assertion. The Appellant, thus, assumes that no such cite exists. In the previous Response dated

July 5, 2007, the Appellant assumed Official Notice was being relied upon to assert that knowledge generally available in the art teaches that a decision to **not output an output pixel** is the same as the decision to **output the second color** for the current pixel.

Appellant requested an express showing of documentary proof to support these elements, according to the documentary proof procedure as set forth in MPEP §2144.03. The MPEP provides that Official Notice without documentary evidence is only appropriate in "rare" cases. MPEP §2144.03(A). "It would not be appropriate for the examiner to take official notice of facts without citing a prior art reference where the facts asserted to be well known are not capable of instant and unquestionable demonstration as being well-known." Id.

In Quintana, there is no selection between a first color and a second color. Instead, the decision is "whether an output pixel should be output for a color component of an image pixel," or not (Quintana, ¶26). Quintana involves the determination of whether to output a given color or to output nothing. This is different from a selection between two colors for output as the final pixel.

Appellant respectfully submits that the specified limitations in independent claims 1, 12 and 20 are allowable for at least the foregoing reasons. Claims 2, 3, 6-11 and 13-19 each depend from these independent claims, and are believed allowable for at least the same reasons as given above. Appellant, therefore, respectfully requests that the §102(b) and §103(a) rejections to these claims be reversed.

### **Dependent Claim 3:**

Dependent claim 3 recites "reducing the accumulated error by an amount corresponding to the threshold in the event that the second color is selected." The Final Office Action cites only the rejection to claim 1, stating that the "value subtracted and the threshold are substantially corresponding" (Final Office Action, p. 6, sec. 8).

While this may be true in an example formulated by the Examiner (Final Office Action, p. 5, l. 15), this is not found in the art itself. Instead, Quintana provides an example where the threshold is "half the value of two to the power of the size of the color space"



(Quintana, ¶28). Appellant can identify no teaching *in the art itself* that the accumulated error be reduced by an amount corresponding to the threshold.

Appellant respectfully submits that the specified limitations in dependent claim 3 is allowable for at least the foregoing reasons. Appellant, therefore, respectfully requests that the §102(b) rejection to this claim be reversed.

#### **8. CONCLUSION**

For these reasons, it is respectfully submitted that the rejection should be reversed.

Respectfully submitted,



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## **9. CLAIMS APPENDIX**

1. (Previously Presented) A method of dithering an image, the method comprising the acts of:

receiving a target color at a high color resolution for a current one of a plurality of pixels of the image, the target color being intermediate between a first color and a second color at a low color resolution;

tracking an accumulated error across the plurality of pixels up to and including the current pixel;

selecting one of the first color and the second color as a final pixel color, wherein the first color is selected in the event that the accumulated error is less than a threshold, wherein the second color is selected in the event that the accumulated error exceeds the threshold, and wherein the accumulated error is reduced below the threshold in the event that the second color is selected;

providing an updated accumulated error to a next one of the plurality of pixels;  
and

outputting the selected final pixel color for display on a display device.

2. (Original) The method of claim 1, wherein the act of tracking the accumulated error includes the acts of:

determining a current error based on a difference between the first color and the target color; and

adding the current error to the accumulated error.

3. (Original) The method of claim 2, further comprising the act of reducing the accumulated error by an amount corresponding to the threshold in the event that the second color is selected.

4-5. (Canceled)

6. (Original) The method of claim 1, wherein the plurality of pixels corresponds to a scan line of a display device.

7. (Original) The method of claim 6, further comprising the act of initializing the accumulated error at a beginning of the scan line.

8. (Original) The method of claim 7, wherein the accumulated error is initialized to a value that depends at least in part on a line number of the scan line.

9. (Original) The method of claim 8, wherein the accumulated error is initialized to a value that is different for successive frames.

10. (Original) The method of claim 1, wherein the threshold corresponds to a difference between respective high resolution representations of the first color and the second color.

11. (Original) The method of claim 1, wherein the target color is one of a plurality of independent color components for the pixel.

12. (Previously Presented) A device for dithering an image, the device comprising:

an accumulator module configured to track an accumulated error across a plurality of pixels of the image;

a conversion module configured to receive a high resolution color signal for a current pixel of the image and to generate a corresponding low resolution color signal;

an adjustment module configured to modify the low resolution color signal from a first color to a second color for the current pixel in the event that the accumulated error exceeds a threshold; and

an output module configured to output the low resolution color signal for the current pixel for display on a display device,

wherein after processing the current pixel, the accumulated error is provided to a next one of the plurality of pixels.

13. (Original) The device of claim 12, wherein the accumulator module includes:  
a current error circuit configured to extract a current error from the high resolution color signal for the current pixel; and  
a first adder circuit configured to add the current error to the accumulated error and to provide an updated accumulated error to the adjustment module.

14. (Original) The device of claim 13, wherein the adjustment module includes:  
a comparator circuit configured to compare the updated accumulated error to a threshold, thereby generating a dither control signal; and  
a second adder circuit configured to receive the low resolution color signal from the conversion module and to adjust the received low resolution color signal based on the dither control signal, thereby generating a final color signal.

15. (Original) The device of claim 14, wherein the comparator circuit is further configured to provide the dither control signal as a feedback signal to the accumulator module, and wherein the accumulator module is further configured to reduce the accumulated error based on the dither control signal.

16. (Original) The device of claim 12, wherein the accumulator module includes a register configured to store the accumulated error.

17. (Original) The device of claim 12, wherein the adjustment circuit includes an adder circuit configured to add the accumulated error to the high resolution color signal, thereby generating an intermediate color signal.

18. (Original) The device of claim 17, wherein the conversion circuit includes a truncator circuit configured to reduce the intermediate color signal to a low resolution color signal.

19. (Previously Presented) The device of claim 18, wherein the truncator circuit is further configured to reduce the intermediate color signal by removing a number of least significant bits and to store the removed least significant bits in a register as a new accumulated error.

20. (Previously Presented) A graphics processing unit comprising:  
a geometry pipeline unit configured to generate pixel data for an image; and  
a scanout module configured to provide the pixel data to a display device,  
wherein the scanout module includes a dithering unit, the dithering unit  
comprising:

an accumulator module configured to track an accumulated error across a plurality of pixels of the image;

a conversion module configured to receive a high resolution color signal for a current pixel of the image and to generate a corresponding low resolution color signal;

an adjustment module configured to modify the low resolution color signal from a first color to a second color for the current pixel in the event that the accumulated error exceeds a threshold; and

an output module configured to output the low resolution color signal for the current pixel for display on the display device.

**10. EVIDENCE APPENDIX**

None.

**11. RELATED PROCEEDINGS APPENDIX**

None.